CLAIMS

What is claimed is:

1. A process for improving the field emission of an electron field emitter comprised of an acicular emitting substance, comprising:

(a) contacting a material with said electron field emitter, wherein said material forms an adhesive contact with said electron field emitter and said adhesive contact provides sufficient adhesive force when said material is separated from said electron field emitter so that a portion of said electron field emitter is removed or rearranged thereby forming a new surface of said electron field emitter; and

(b) separating said material from said electron field emitter.

2. The process of Claim 1 wherein when said material is separated from said electron field emitter a portion of said electron field emitter is removed.

3. The process of Claim 2 wherein said acicular emitting substance is acicular carbon.

4. The process of Claim 3 wherein said acicular carbon is comprised of carbon nanotubes.

5. The process of Claim 4 wherein said carbon nanotubes are single wall carbon nanotubes.

6. The process of Claim 5 wherein said single wall carbon nanotubes are laser ablation grown single wall carbon nanotubes.

7. The process of Claim 3 wherein said acicular carbon is comprised of carbon fibers grown from the catalytical decomposition of carbon-containing gases over small metal particles, each of which said fibers has graphene platelets arranged at an angle with respect to the fiber axis so that the periphery of said carbon fiber consists essentially of the edges of said graphene planes.

8. The process of Claim 5, wherein said carbon nanotubes are less than about 9 wt % of the total weight of said electron field emitter.

9. The process of Claim 5, wherein said carbon nanotubes are less than about 5 wt % of the total weight of said electron field emitter.

10. The process of Claim 5, wherein said carbon nanotubes are less than about 1 wt % of the total weight of said electron field emitter.

11. The process of Claim 5, wherein said carbon nanotubes are about 0.1 wt % to about 2 wt % of the total weight of said electron field emitter.

12. A process for improving the field emission of an electron field emitter comprised of an acicular emitting substance, comprising applying a force to the surface of said electron field emitter in a direction essentially normal to the plane

of the electron field emitter such that said force fractures said electron field emitter thereby forming a new surface of said electron field emitter.

13. A process for improving the field emission of an electron field emitter comprised of an acicular emitting substance, comprising applying a force to the surface of said electron field emitter in a direction essentially normal to the plane of the electron field emitter wherein said force results in the removal of a portion of said electron field emitter thereby forming a new electron field emitter surface.

14. The process as in Claims 12 or 13, wherein the acicular emitting substance is acicular carbon.

15. The process of Claim 14 wherein said acicular carbon is comprised of carbon nanotubes.

16. The process of Claim 15 wherein said carbon nanotubes are single wall carbon nanotubes.

17. The process of Claim 16 wherein said single wall carbon nanotubes are laser ablation grown single wall carbon nanotubes.

18. A composition for use as a screen printable paste containing solids comprising carbon nanotubes, wherein said carbon nanotubes are less than 9 wt % of the total weight of solids in said paste.

19. The composition of Claim 18, wherein said carbon nanotubes are less than about 5 wt % of the total weight of solids in said paste.

20. The composition of Claim 18, wherein said carbon nanotubes are less than about 1 wt % of the total weight of solids in said paste.

21. The composition of Claim 18, wherein said carbon nanotubes are about 0.01 wt % to about 2 wt % of the total weight of solids in said paste.

22. A composition for use as a screen printable paste containing solids comprising carbon nanotubes, silver and glass frit, wherein there is about 0.01-6.0 wt% nanotubes, about 40-75 wt % silver in the form of fine silver particles and about 3-15 wt % glass frit based on the total weight of the paste.

23. The composition of any one of Claims 18-22, wherein a carbon nanotube suspension is used in making said composition and said suspension is prepared by ultrasonic mixing of the carbon nanotubes in an organic medium.

24. An electron field emitter comprised of an acicular emitting substance wherein the emission of said acicular emitting substance has been improved by the process of Claims 1, 12 or 13.

25. An electron field emitter comprised of acicular carbon carbon wherein the emission of said acicular carbon has been improved by the process of Claim 3.

26. An electron field emitter comprised of carbon carbon nanotubes wherein the emission of said carbon nanotubes has been improved by the process of Claim 4.

27. An electron field emitter comprised of single wall carbon nanotubes wherein the emission of said single wall carbon nanotubes has been improved by the process of any one of Claims 45 or 8-11.

28. An electron field emitter comprised of carbon fibers grown from the catalytical decomposition of carbon-containing gases over small metal particles, each of which said fibers has graphene platelets arranged at an angle with respect to the fiber axis so that the periphery of said carbon fiber consists essentially of the edges of said graphene planes wherein the emission of said carbon fibers has been improved by the process of Claim 7.

29. An electron field emitter comprised of acicular carbon wherein the emission of said acicular carbon has been improved by the process of Claim 14.

30. A field emission triode with an electron field emitter comprised of an acicular emitting substance wherein the emission of said acicular emitting substance has been improved by the process of Claims 1, 12 or 13.

31. A field emission triode with an electron field emitter comprised of acicular carbon wherein the emission of said acicular emitting substance has been improved by the process of Claim 3.

32. A field emission triode with an electron field emitter comprised of carbon nanotubes wherein the emission of said carbon nanotubes has been improved by the process of Claim 4.

33. A field emission triode with an electron field emitter comprised of single wall carbon nanotubes wherein the emission of said single wall carbon nanotubes has been improved by the process of any one of Claims 5 or 8-11.

34. A completely screen-printed field emission triode with an electron field emitter comprised of an acicular emitting substance wherein the emission of said acicular emitting substance has been improved by the process of Claims 1, 12 or 13.

35. A completely screen-printed field emission triode with an electron field emitter comprised of acicular carbon wherein the emission of said acicular emitting substance has been improved by the process of Claim 3.

36. A completely screen-printed field emission triode with an electron field emitter comprised of carbon nanotubes wherein the emission of said carbon nanotubes has been improved by the process of Claim 4.

37. A completely screen-printed field emission triode with an electron field emitter comprised of single wall carbon nanotubes wherein the emission of

said of single wall carbon nanotubes has been improved by the process of any one of Claims 5 or 8-11.

38. A lighting device with an electron field emitter comprised of carbon nanotubes wherein the emission of said carbon nanotubes has been improved by the process of Claim 4.

39. A lighting device with an electron field emitter comprised of single wall carbon nanotubes wherein the emission of said of single wall carbon nanotubes has been improved by the process of any one of Claims 5 or 8-11.

40. A process for reducing emission hot spots in an electron field emitter device wherein the electron field emitter is comprised of acicular carbon, comprising exposing said electron field emitter to a reactive gas while maintaining the anode voltage above the level of the normal operating anode voltage.

41. The process of Claim 40 wherein said reactive gas is oxygen.

42. The process of Claim 41 wherein said acicular carbon is comprised of carbon nanotubes.

43. The process of Claim 42 wherein the emission of said electron field emitter has been improved by the process of Claim 4 prior to undergoing the process for reducing emission hot spots.

44. A process for making a cathode assembly with a normal gate triode array using photoimagable thick film pastes, comprising:

(a) printing on a substrate a photoimagable silver cathode layer, photo-imaging and developing the silver cathode layer and then firing to produce silver cathode feed lines on the substrate;

(b) printing a photoimagable electron field emitter layer on top of the silver cathode feed lines and the exposed substrate, photoimaging and developing the electron field emitter layer into dots, rectangles, or lines on the silver cathode feed lines;

(c) printing one or more uniform photoimagable dielectric layers on top of the silver cathode feed lines and the electron field emitters and drying the dielectric;

(d) printing a layer of photoimagable silver gate lines on top of the dielectric and drying this layer of silver gate lines;

(e) using a photo-mask containing the via or slot pattern to image both the silver gate and the dielectric layers in a single exposure, thereby placing the vias directly on top of the electron field emitter dots, rectangles, or lines; and

(f) developing the silver gate and dielectric layers to reveal the electron field emitter layer at the base of the vias and co-firing

the electron field emitter, dielectric, and silver gate layers under conditions that are compatible with the electron field emitter.

45. The process of Claim 44 wherein said electron field emitter is comprised of acicular carbon.

46. The process of Claim 45 wherein said acicular carbon is comprised of carbon nanotubes.

47. A cathode assembly with a normal gate triode array made by the process of Claim 46.

48. The cathode assembly of Claim 47 wherein the emission of said electron field emitter has been improved by the process of Claim 4.

49. A process for making a cathode assembly with an inverted gate triode array in a rib-geometry using photoimagable thick film pastes comprises:

(a) printing on a substrate a photoimagable silver gate layer, photo-imaging and developing the silver gate layer and then firing to produce silver gate lines on a substrate, wherein each silver gate line width extends well beyond the width of the electron emitters it is to control and the gate line width covers much of the substrate in the vicinity of the electron emitters;

(b) printing one or more uniform photoimagable dielectric layers on top of the silver gate lines and the exposed substrate and drying the dielectric;

(c) printing a photoimagable silver cathode feed layer on top of the dielectric and drying the silver cathode feed layer;

(d) printing a photoimagable electron field emitter layer and drying the electron field emitter layer;

(e) using a photo-mask containing a rib pattern to image the electron field emitter, the cathode feed and the dielectric layers in a single exposure thereby achieving perfect alignment of the electron field emitters and the cathode feed lines on top of the dielectric ribs; and

(f) developing the electron field emitter, cathode feed, and dielectric layers to produce the rib geometry and co-firing the electron field emitter, cathode feed, and dielectric layers under conditions that are compatible with the electron field emitter.

50. The process of Claim 49 wherein said electron field emitter is comprised of acicular carbon.

51. The process of Claim 50 wherein said acicular carbon is comprised of carbon nanotubes.

52. A cathode assembly with an inverted gate triode array made by the process of Claim 49.

53. The cathode assembly of Claim 52 wherein the emission of said electron field emitter has been improved by the process of Claim 4.